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(54) Title of invention: Forming method of resist pattern

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PATENT SPECIFICATION

1. TITLE OF INVENTION
Forming method of resist pattern

2. CLAIM
(1) A forming method of resist pattern which is characterized by; opposing a master pattern provided with valley sections with a pattern shape corresponding desired resist pattern, and a substrate on which the resist patter is to be formed, with hardening resin for resist located between them; sandwiching the hardening resin by applying a pressure on the master pattern and the substrate from both sides; then curing the hardening resin by irradiating heat or electromagnetic radiation followed by releasing the master pattern to form a patterned relief layer comprising the hardening resin on the substrate; and after this by uniformly etching entire surface to completely remove the hardened resin at the valley sections of the relief layer, and form a resist layer comprising the remaining hardening resin at the peak sections of the relief layer.
(2) A forming method of resist pattern that is described in Claim 1 and is to form a patterned relief layer having a ratio of the thickness of peak section A and the thickness of valley section B (A/B) being 1.2/1 or more.
(3) In the resist pattern forming method that is described Claim 1, a forming method of resist pattern which is characterized by using polymerizing monomer or a mixture of the monomer and hardening resin, in place of the hardening resin.

3. DETAILED DESCRIPTION OF THE INVENTION

[Field of industrial applications]
This invention concerns forming method of resist patterns which is applied when various patterning is done on a substrate or a layer on a substrate with such as etching.

[Prior technologies and the problems that the invention is to solve]
Patterning has been applied by such as etching in various fields in semiconductor industries and others, and photo-lithography method has been generally known as a forming method of forming resist patterns that is done prior to the application of etching. This photo-lithography method is to coat photo-resist on the material-to-be-worked, than after applying a treatment to improve contact between the photo-resist and the material-to-be-worked by pre-baking, apply ultraviolet light exposure through a mask having a desired pattern, and then selectively dissolve to remove either exposed part or un-exposed part of the photo-resist with specific development solution, to form a resist pattern.

However, this photo-lithography method has extremely many processes which is obvious from the fact that this process requires at least a process to wash the material-to-be-worked such as substrate, a process to coat photo-resist on the material-to-be-worked, pre-baking process to improve the contact between the material-to-be-worked and coated photo-resist, and exposure process to expose ultraviolet light through a specific mask, development process to selectively remove one of the exposed part or un-exposed part of the resist using the difference of dissolving property of them into development solution, and further, post baking process that is to harden the resist by heat treatment as required may be applied; and finally etching process is applied after the completion of these processes; and any of the processes require relatively advanced handling

and high skills.

For example, because existence of a fine foreign object in a size of one tenth of the size of the minimum size of resist pattern to be applied will be a cause of pattern defect, precise and secure washing is necessary and extraordinary caution and control system is needed in all of the series of processes after the washing against foreign objects from contaminating or attaching. At the coating process, the photo-resist must be coated in uniform thickness, and a coating apparatus that is able to do that precise coating is necessary, and the coating condition must be strictly managed. In the exposure process, an exposure optical system that generates parallel light is necessary in order to highly precise exposure through a mask, and apparatus that has this type of optical property, especially the one that has greater than 30 cm square is extremely precise and expensive apparatus. As the more precise optical system, a projection exposure optical system is currently used that uses lenses and mirrors, however, the effective exposure area of maximum 15 cm square is the limit, and it is more precise and expensive apparatus than above described parallel light type. In the development process, an apparatus is needed that is able to well control such as contact level of the development solution to the object-to-be-processed and sufficient management is needed, in order not to cause variation in the degree of development.

Further, the photo-lithography method is able to form patterns from tens of micro meters to hundreds of micro meters in the field of metal etching of such as shadow masks that has relatively large pattern size, and is able to form patterns one micro meter or less in the field of such as LSI that has smaller pattern size, however, it requires extremely special and expensive equipment and especially the process for large substrate and others has severe limitations in equipment and the equipment itself is further more expensive.

As described in above, although the photo-lithographic method is able to form highly precise and fine resist patterns, there are various problems that there are large limitations in apparatus and the apparatus are expensive, and there are many process stapes and long.

On the other hand, as a means to conduct the forming of the resist pattern in relatively large handling capacity and with relatively low cost apparatus, the printing method has been known. For example, in the production field of such as print circuit boards, silk screen printing has been used and this type of printing method has been applied for such as the forming of soldering resist pattern, as well as the forming of resist patterns for etching.

However, it is very difficult to form fine patterns with these printing methods, and for example it is not able to print and form patterns in 100 μm or less line width with said silk screen printing method, and even with other printing methods situation is similar. Therefore, although apparatus and process will be simplified with the printing method compared with said lithography method, there is a drawback that there is a significant problem in preciseness of obtained resist pattern, and especially it is not able to make fine patterns.

[Means to solve the problems]

The inventors and others have proceeded with an investigation for solving the problems of said previous technology, and as a result they discovered that, a forming method (photo-polymer method) that is able to form micro fine pattern, able to use simpler equipment, and able to make high precision patterns with relatively simple process, is able to be used as a production method of resist pattern replacing previous photo-lithography method or printing method, and they continued the investigation based on this knowledge.

Above described photo-polymer method is a forming method that is to insert an electromagnetic radiation curing resin such as ultraviolet light or electron beam curing resin

between base material and a forming pattern, and to cure said resin by irradiating electromagnetic radiation to obtain formed material that is applied with desired relief pattern on its surface by the forming pattern, which has been generally used as a technique for replicating relief shapes and it is able to exactly replicate a pattern of relief shape in a size of even smaller than 1 μm. Therefore, in recent years, technologies have been proposed which are applied for the replication of hologram sheet or production of optical memory sheet and lens sheets such as prism lens sheet.

However, this technique has it objective to strictly reproduce the shape of relief, and of course it is impossible to directly apply this method for forming resist patterns, therefore, we did various investigations on those points to reach this invention.

Namely, this invention has its essential points as;

(1) a forming method of resist pattern which is characterized by; opposing a master pattern provided with valley sections with a pattern shape corresponding desired resist pattern, and a substrate on which the resist patter is to be formed, with hardening resin for resist located between them; sandwiching the hardening resin by applying a pressure on the master pattern and the substrate from both sides; then curing the hardening resin by irradiating heat or electromagnetic radiation followed by releasing the master pattern to form a patterned relief layer comprising the hardening resin on the substrate; and after this by uniformly etching entire surface to completely remove the hardened resin at the valley sections of the relief layer, and form a resist layer comprising the remaining hardening resin at the peak sections of the relief layer,

(2) A forming method of resist pattern that is described in Claim 1 and is to form a patterned relief layer having a ratio of the thickness of peak section A and the thickness of valley section B (A/B) being 1.2/1 or more, and

(3) in the resist pattern forming method that is described Claim 1, a forming method of resist pattern which is characterized by using polymerizing monomer or a mixture of the monomer and hardening resin, in place of the hardening resin.

[Embodiment examples]

In the following, embodiment examples of this invention is explained based on drawings.

Figure 1 is a cross sectional explanation drawing of each process showing an embodiment example of the method of this invention, and Figure 2 is a cross sectional explanation drawing of each process showing another embodiment example of the method of this invention. In the drawings, 1 is master pattern, 2 is valley section in a shape of pattern corresponding to the resist pattern that is located on the master pattern 1, 3 is substrate on which the resist pattern is to be formed, and 4 is hardening resin for resist. In this invention, forming of similar resist pattern may be also done by using polymerizing monomer or a mixture of polymerizing monomer and hardening resin, in place of the hardening resin 4.

Above described master pattern 1 is made by using glass plate, plate or film of plastics such as acrylic resin, PET, polycarbonate and polyether, or metal plate of such as stainless steel and aluminum as the substrate, and desired pattern is directly machined or etched with etching method in this to form the valley section 2, or with said photo-polymer method to form the valley section 2. As the substrate, rather flexible materials such as plastics or metal plate than stiff ones such as glass, are easier in releasing later described process of the master pattern. Although easy release is possible even with using glass by a combination of materials. Also it is able to coat releasing agent on the side of the valley section 2 or directly impregnate into the resin base material in order to make the releasing work of the master pattern 1. As the releasing agent, it is

able to mention that silicone oil, higher aliphatic acids such as stearic acid and their metal salts may be used, and in concrete, it is able to mention Gafak* RB410, Gafak* RL210, Gafak* RD510 (above made by Toho Chemical), Prisurf* 217E, Prisurf* A-2085 (above made by Daiich Kogyo Seiyaku), and Lastin* (made by Ajinomoto).

** Translator's note: All these brand names are phonetic translation and the original spellings in English are not certain.*

The substrate 3 is not limited within specific for its material. The substrate 3 as shown in drawings are all known ones provided with an etching layer 13 on them.

As the hardening resin 4 for resist that is sandwiched between the master pattern 1 and the substrate 3, such as electromagnetic radiation curing type resins such as electron beam or ultraviolet light curing resin and heat curing type resins are mentioned. The electromagnetic radiation curing type regin generally hardens by acrylic type double bond polymerization reacting with the energy of ultraviolet light or electron beam, and in concrete as electron beam curing type, it is able to use such as Goselac* UV7000B and Goselac* UV4200T (above made by Nippon Gosei), and Diabeam UK6034 and Diabeam UK6033 (above made by Mitsubishi Rayon). Also, when ultraviolet light curing it is necessary to add a small amount of photo-reaction initiator to those, and it is able to use such as Darocure* 1173, Darocure* 1115 and darocure* 953 (above made by Merk), Irgacure* 184, Irgacure* 500 and Irgacure* 651 (avove made by Tegabagy**), as the concrete ultraviolet curing types.

**Translator's note: All these (brand) names are phonetic translation and the original spellings in English are not certain.*

***Translator's note: This "Tegabagy" is a phonetic translation of what it is written in Japanese, however, correct name shall be "Ciba Geigy".*

Further, monomers as reactive thinner may be added in appropriate amount to the hardening resin 4 for controlling viscosity as needed. As the concrete example of the monomers, such as Aronix* M150 and Aronix* 5700 (abopve made by Toa Gosei), and Kayarad* HX620, Kayarad* TMPTEA and Kayarad* TC110S (above made by Nippon Kayaku), and they need to be compatible with above described hardening resin, therefore, they are used by appropriately selected. Further, small amount of surface active agent, mold release agent, etc. may be added to the hardening resin 4. By adding the surface active agent it is able to further increase the flow of the resin compound, and further it provides low bubbling property, bubble suppressing property, and high wetting property, which improves easiness of handling and is able to minimize the shoulder thickness of the valley sections of later described pattern relief layer as well, at the same time. As the concrete examples of the surface active agent, it is able to mention such as Florad FC430, Florad FC431 (above made by 3M), and Modaflow* (made by Monsanto). As the mold releasing agent, above described ones may be similarly used, and by adding these mold releasing agent, it is able to make the releasing of hardened resin from the master pattern and able to reduce residual stress at releasing from the mold.

** Translator's note: All these brand names are phonetic translation and the original spellings in English are not certain.*

At first, the method of this invention places the hardening resin 4 for resist between the master pattern 1 and the substrate 3, and applies pressure on the both sides of the master pattern 1 and the substrate 3 with appropriate pressurization means, so that the hardening resin 4 expands into thin and uniform thickness while being in a sandwiched condition between the master pattern and the substrate.

Placing of the hardening resin 4 may be done by dripping on the master pattern, for example,

and as the above described means of pressurizing, it is able to apply such as a pressurizing method with pressurizing plates as shown in Figure 2 (c) as well as the roll pressurization method as shown in a drawing in Figure 1 (b). As the means for pressurizing, the method to press with holding press plates 10 from top and bottom is the simplest, however, a roll pressurization method, that is to nip between two pressure rolls 11 spaced in constant distance and rotate the rolls while applying a pressure, is desirable from the standpoint that it is able to apply uniform pressure. The hardening resin 4 is dripped normally at the center of the master pattern 1 (refer to Figure 2 (a)), however, when the roll pressurizing method is applied, dripping at near one end of the master pattern 1 (refer to Figure 1 (a)) is desirable for uniformly spread the resin 4. In the method of this invention it is important to handle in the operation of sandwiching said hardening resin 4 that bubbles would not be entrapped in the resin compound. As the countermeasure for this, for example, the master pattern is placed horizontally, after dripping the resin 4, the substrate 3 is held above the master plate 1 slightly inclined from the horizontal, then the substrate 3 is slowly lowered and when one end of the substrate almost touches the master pattern 1, opposing other end is further lowered to hold in parallel condition to the master pattern. At this time, the resin 4 starts to expand on the surface of the valleys of the master pattern while contacting with the substrate 3 and being sandwiched. After this, it may be pressed on both sides, master pattern 1 and substrate 3, to further expand the resin 4 and make its thickness uniform. In order to apply uniform pressure on the surfaces of the master pattern and the substrate, a method to apply air pressure on both side, the master pattern 1 and the substrate 3, or a method to make the inside that is sandwiched between the master pattern and the substrate in a condition of reduced pressure and uniformly pressurize using the pressure of atmosphere, may be used, or these methods may be used together.

Then, heat or electromagnetic radiation 5 is irradiated to cure the hardening resin 4 that is sandwiched between the master pattern 1 and the substrate 3.

This irradiation is done through the side of master pattern and/or substrate where the heat or electromagnetic radiation is able to transmit or pass. As the electromagnetic radiation, such as ultraviolet light and electron beam may be used, and ultraviolet light is desirable from the standpoint of easy application. As the ultraviolet light source, such as a super high pressure mercury vapor lamp, a high pressure mercury vapor lamp and a metal halide lamp, may be used. For example, sufficient curing is able to be done with high pressure mercury vapor lamp at the wave length of 365 nm and energy of about 1 J/cm^2. Further, the irradiation on the hardening resin 4 for curing is more desirable to be done simultaneously while applying said pressurization for controlling the thickness of the hardening resin, and for example, in case of applying roll pressing, it is better to design the application of curing by immediately irradiating ultraviolet light directly after passing through the rolls. Further, there are cases that heat is also irradiated from a light source when irradiating ultraviolet light, therefore, in order to prevent the reduction of dimensional accuracy of pattern by thermal expansion of the master pattern 1 and the substrate 3 due to heating with this heat, there is a need to control heat radiation by using such as a cold mirror as necessary.

Then after curing the hardening resin 4, the master pattern 1 is released from the surface of the substrate 3.

This releasing may be very easily done if either one or both of the master pattern 1 and the substrate 3 are flexible material, however, if both are stiff material such as glass, it can not be easily done unless the boundary between the master pattern 1 and the hardening resin is release treated ahead of time. The releasing treatment is done by either coating releasing agent such as

silicone oil on the side of valley sections 2 of the master pattern 1, or by adding to the hardening resin 4. Also for releasing stiff materials on both sides, it is better to fix backsides of the master pattern 1 and the substrate 3 to jigs such as suction cups as shown in Figure 2 (d), and gradually release from one end of the master pattern 1 or the substrate 3 by pulling the jigs. In this case, smoother releasing is possible if high pressure air is blown into the releasing gap when one end has started to slightly release.

By the above described releasing, the hardened resin layer is removed from he master pattern 1 side and adheres/transfers to the substrate 3 side, and as a result, a patterned relief layer 6 is formed that comprises cured resin that is formed by the master pattern 1 on the substrate 3 (refer to Figure 1 (d) and Figure 2 (d)). Because the step height of the pattern in the relief layer 6 is almost exact replica of the steps of the master pattern 1, therefore, control of the pattern step height is able to be done by the pattern of the master pattern alone, namely by the adjustment of the valley sections 2. Further, the thickness of the relief layer 6 , especially the layer thickness of the valley section 8 is able to be appropriately controlled with viscosity, wetting property and dripping amount of the hardening resin 4 and pressurizing condition of the master pattern and the substrate.

This invention at last applies etching, which is uniform across entire surface of the valley sections 8 and peak sections 9 of the relief layer, to the substrate 3 that has been formed with the pattern relief layer 6. By this etching, cured resin is completely removed only at the valley sections 8 of the relief layer as shown in Figure 1 (e) and Figure 2 (e), and the cured resin at the relief layer peak sections 9 would be also removed at the same amount with the valley sections 8, however, a part of it remains and a resist layer 7 comprising this remaining part of the cured resin is formed on the substrate 3.

For the above described etching, it is able to apply an etching method that does using chemical or solvent depending on the composition of the hardening resin, however, because there are many cases that the hardening resin layer would cause swelling prior to being dissolved in chemical or solvent with the ordinary hardening resins, and locations with thick layer and locations with thin layer would both similarly swell which causes deformation of the pattern shape of the relief layer, therefore, there is a problem that it is difficult to selectively and completely dissolve and remove only the valley sections of the relief layer where the thickness is thin, which is required by this invention.

Therefore, it has been confirmed that the dry etching method is the most desirable for said etching by the result of investigation by the inventors and others. With this dry etching method, surface of organic substance that is a object of etching evaporates by reacting with active gas (oxygen plasma for example), therefore, etching is done in sequence from the surface side of the material to be etched. This invention utilizes this feature ant it is able to gradually proceed etching in the direction of film thickness from the surface of the cured resin layer of the relief layer 6, and furthermore, because its rate of etching is constant regardless the valley sections or peak sections of the relief layer, it is able to completely remove the cured resin at only the valley sections 8 of the relief layer where the film thickness is thin, as a result, and partially leave the cured resin at the peak sections 9 of the relief layer where the film thickness is thick. As the dry etching method, plasma etching method and a etching method by ozone oxidation are mentioned.

In order to be able to form a good resist layer 7 with above described etching of relief layer 6 in this invention, it is important to form a patterned relief layer 6 wherein the ratio of film thickness A of peak sections 9 and film thickness B of valley sections A of the relief layer (A/B) is 1.2/1 or greater. When the ratio of film thickness is smaller than said value range, it is difficult

to apply an etching treatment that completely removes the cured resin at the valley sections 8 only but partially leaves the cured resin at the peak sections 9, and in a chemical etching method, there is a problem that especially if difference in dissolving property between the valley sections 8 and peak sections 9 is small, the cured resin at 8 and 9 will be dissolved together and removed. Further, when the dry etching is applied, the step between the peak and valley of the relief layer may be a difference of sub-micron, if the area of etching treatment is small, and for example in the etching of treatment area of 1 cm x 1 cm, forming of resist is possible even at a difference of 0.2 μm, however, if treating area is larger, it is necessary to set the difference of the peak and valley to be greater.

The substrate 3 formed with a resist pattern by the method of this invention is completed with desired pattern forming to the substrate 3 by applying an ordinary etching treatment after this and finally removing the resist layer 7.

The forming method of resist pattern of this invention is applicable as a pattern forming method for making various products that require forming of micro fine resist patterns, as well as for forming micro fine resist patters for producing semiconductors.

In the following, this invention is further explained in detail mentioning concrete embodiment examples.

Embodiment example 1

Forming of a resist pattern is done following an embodiment example that is shown in drawings in Figure 1.

At first, using the one formed with 2 μm deep valleys of relief pattern on a polycarbonate substrate of 15 cm in length and width and 0.3 mm in thickness with photo-polymer method using ultraviolet light hardening resin as the master pattern 1, an ultraviolet light curing resin compound 4 was dripped with flow coating method on the left side (side of roll 4*) of this master pattern (Figure 1 (a)). This resin compound is a resin compound prepared by mixing in a ratio of 30 weight percent of IPDI base urethane type acrylate resin (Goselak** UV 7000B, made by Nippon Gosei) as oligomer, and 70 weight percent Kayarad** FHX220 (made by Nippon Kayaku), and further adding 2 weight percent of Irgacure** 184 (made by Ciba Geigy) as photo-initiator and adjusted to 180 cps of viscosity.

** Translator's note: This "roll 4" shall be an apparent mistake of "roll 11".*

*** Translator's note: All these (brand) names are phonetic translation and the original spellings in English are not certain.*

Using a substrate 3 which is coated with indium oxide (ITO) on a glass substrate to be 10 Ω/□ of film in 1 mm thickness, this substrate 3 was mounted over a master pattern 1 from the top, and the pressure roll 11 was rolled toward right direction in the drawing at a velocity of 50 cm/min. to apply pressure (Figure 1 (b)). At this time air bubbled that exist between the master pattern 1 and the substrate 3 is expelled at a point shown by P in the drawing. Also, ultraviolet light was irradiated at 160 W/cm^2 immediately after applying roll pressing using an ultraviolet light source, to cure the ultraviolet light hardening resin 4 (Figure 1 (c)).

Then the master pattern was released after removing the pressure to form a patterned relief layer 6 on the substrate 3 (Figure 1 (d)). This relief layer had a pattern step in 2 μm, thickness of the valley sections in 1 μm and thickness of peak sections in 3 μm.

Finally, the relief layer was dry etched with oxygen plasma to completely remove the hardened resin at the valley sections, and a resist layer 7 which is in identical pattern shape with the pattern of the peak sections 9 of the relief layer was able to obtain. The cured resin at the peak section 9 was similarly etched with the valley sections 8 and film thickness was reduced to

2 μm at last.

By etching the substrate 3 that is formed with the resist pattern with iron chloride type etching solution and removing the resist layer, an ITO layer comprising the same pattern with the resist layer 7 was able to be obtained.

Embodiment example 2

Forming of a resist pattern is done following an embodiment example that is shown in drawings in Figure 2.

At first, surface of glass substrate of 30 cm in length and width and 3 mm in thickness was etched to valley sections of a specific pattern in 3 μm deep with photo-lithography method , and then silicone oil (made by Toho Chemical, Gafack* RE410) was coated on the surface as the releasing agent to make a master pattern 1, and the ultraviolet curing resin compound 4 that is the same as the embodiment example 1 was dripped at the center of this master pattern (Figure 2 (a)).

Then, the glass substrate 3 having an ITO layer that is the same as the embodiment example 1 was mounted slightly in inclined position and gradually pressed against the master pattern 1 (Figure 1 (b)). At this moment, air bubbles existing between the master pattern 1 and the substrate 3 are expelled at the points shown by P in the drawing.

Then with a pressure plates 10, 10 the master pattern 3* and the substrate 1* were pressed from the top and bottom. A part of the bottom pressure plate was constructed with transparent glass where it contacts with the master pattern 1 and the resin compound 4 was cured by irradiating ultraviolet light at 160 W/cm** through the bottom pressure plate for 30 seconds at the same time with pressing (Figure 2 (c)).

**Translator's note: These "master pattern 3" and "substrate 1" shall be mistakes of "master pattern 1" and "substrate 3" respectively.*

***Translator's note: This "cm" shall be a mistake of "cm^2".*

After the curing, the pressure was removed and both were released while backsides of the master pattern 3* and the substrate 1* were suctioned with suction cups 12, and a pattern relief layer 6 was formed on the substrate 3 (Figure 2 (d)). This relief layer had a pattern step in 3 μm, thickness of the valley sections 8 in 1 μm and thickness of peak sections 9 in 4 μm.

**Translator's note: These "master pattern 3" and "substrate 1" shall be mistakes of "master pattern 1" and "substrate 3" respectively.*

Finally, the relief layer was dry etched with oxygen plasma to completely remove the hardened resin at the valley sections 8, and a resist layer 7 which is in the pattern of the peak sections of the relief layer was able to be obtained (Figure 2 (e)). The cured resin at the peak section 9 was similarly etched and film thickness was reduced to 2 μm at last.

Embodiment example 3

Forming of a resist pattern was done following an embodiment example that is shown in Figure 2.

At first, oligo-ester-acrylate type ultraviolet light curing resin compound 4 was dripped at the center of a master pattern 3 that is the same as the embodiment example. This resin compound 4 is 98 weight percent of Kayrad** TMPTA (made by Nippon Kayaku) added with 2 weight percent of Irgacure** 184 (made by Ciba Geigy) as photo-initiator.

**Translator's note: This "master pattern 3" sahll be a mistake of "master pattern 1".*

***Translator's note: All these (brand) names are phonetic translation and the original spellings in English are not certain.*

Then, the glass substrate 3 having an ITO layer 13 that is the same as the embodiment

example 1 was mounted slightly in inclined position and gradually pressed against the master pattern. Then the master pattern and the substrate were pressed with the same means of pressing witht he embodiment example 2, and at the same time the ultraviolet light curing resin 4 was cured by irradiating ultraviolet light at 160 W/cm* through the bottom pressure plate for 30 seconds.

**Translator's note: This "cm" shall be a mistake of "cm^2".*

Then as same as the embodiment example 2, the master pattern 3* and the substrate 1* were released by using suction cups, and a pattern relief layer 6 was formed on the substrate 3. This relief layer had a pattern step in 3 μm, thickness of the valley sections in 1 μm and thickness of peak sections in 4 μm.

**Translator's note: These "master pattern 3" and "substrate 1" shall be mistakes of "master pattern 1" and "substrate 3" respectively.*

Finally, the substrate having the relief layer was etched in 2 % water solution of caustic soda to remove the cured resin at the valley section of the relief layer, and a resist layer was obtained. At this time the cured resin at the peak sections was also etched and the film thickness was reduced to 3 μm.

[Effect of the invention]

As above explained, according to this invention, it is able to form fine and highly precise resist patterns which is comparable with previous photo-lithography method, and it is not necessary to use an expansive and complicated equipment that is used in the photo-lithography method when making a pattern, and further, it is able to be done with relatively simple and less and short process steps without complicated controls, therefore, it is able to form resist patterns easily and in high precision and high efficiency, compared to previous method. Further, if the layer thickness of peak sections and valley sections of the patterned relief layer that is formed in a substrate is set at the specific ratio as described above, forming of securer and clearer resist patterns in better repeatability is enabled.

4. Brief explanation of drawings

Figure 1 is a cross sectional explanation drawing of each process showing an embodiment example of the method of this invention, and Figure 2 is a cross sectional explanation drawing of each process showing another embodiment example of the method of this invention.

1: master pattern, 2: valley section, 3: substrate,
4: hardening resin for resist,
5: heat or electromagnetic radiation,
6: patterned relief layer, 7: resist layer
8: relief layer valley section, 9: relief layer peak section

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Figure 1

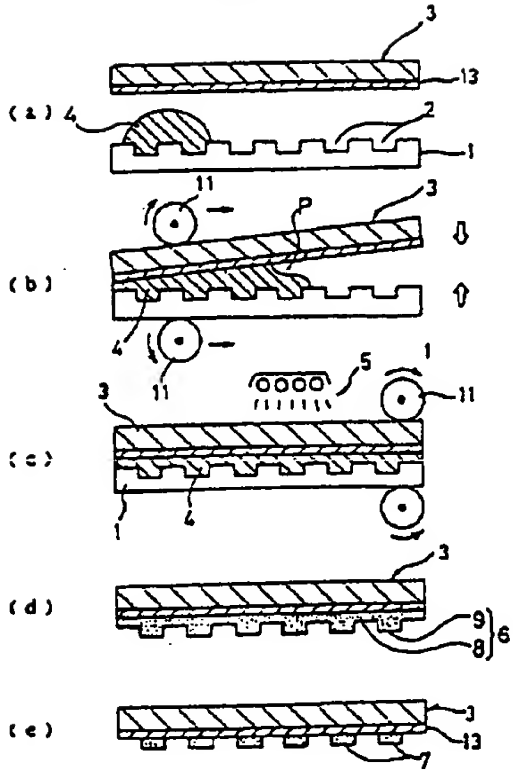
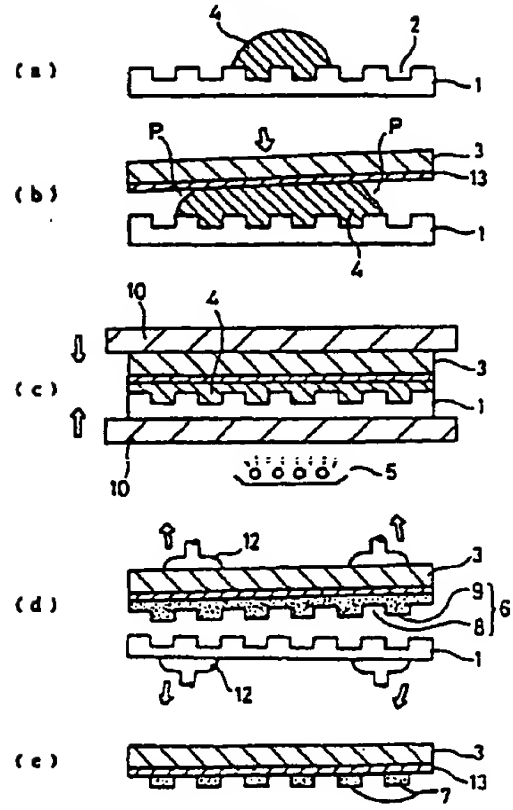


Figure 2



1: master pattern, 2: valley section
3: substrate, 4: hardening resin for resist
5: heat or electromagnetic radiation, 6: patterned relief layer,
7: resist layer, 8: relief layer valley section

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⑭発明の名称　レジストパターンの形成方法

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明細書

1.発明の名称

レジストパターンの形成方法

2.特許請求の範囲

(1) 所望のレジストパターンに相応するパターン形状の凹部を設けたマスター版とレジストパターンを形成すべき基板とを、両者間にレジスト用硬化性樹脂を介在させた状態で封緘させ、マスター版と基板をその両側から加圧して硬化性樹脂を挟持し、次いで、熱又は電離放射線を照射して硬化性樹脂を硬化させた後、マスター版を剥離して基板上に硬化樹脂からなる凹凸レリーフ層を形成し、しかる後、全面を均一にエッチングして該レリーフ層凹部の硬化樹脂を完全に除去すると共にレリーフ層凸部の既存した硬化樹脂からなるレジスト層を形成することを特徴とするレジストパターンの形成方法。

(2) 凸部の層厚Aと凹部の層厚Bの比(A/B)が1.2/1以上となる凹凸レリーフ層を基板上に形成する請求項1記載のレジストパターンの形成方法。

(3) 請求項1記載のレジストパターンの形成方法において、硬化性樹脂に代えて重合性モノマー又は該モノマーと硬化性樹脂との混合物を用いたことを特徴とするレジストパターンの形成方法。

3.発明の詳細な説明

(産業上の利用分野)

本発明は、基板或いは基板上の層にエッチング法等により各種パターン加工を施す際に適用されるレジストパターンの形成方法に関する。

(従来の技術及び発明が解決しようとする課題)

従来より半導体製造をはじめとした各種分野においてエッチング法等によるパターン加工がなされており、そのエッチングを施すに先立って行われるレジストパターンの形成手段として一般にフォトリソグラフィ法が知られている。このフォトリソグラフィー法は、被加工材上にフォトレジストを塗布し、これをプリベークしてフォトレジス

トと被加工材の密着性を向上させる処理を施した後、所望のパターンを有するマスクを介して紫外線露光を行い、しかる後、所定の現像液にてフォトレジストの露光部分あるいは非露光部分のどちらかを選択的に溶解除去してレジストパターンを形成するものである。

ところが、このフォトリソグラフィ法は基板等の被加工材を洗浄する工程、フォトレジストを被加工材へ塗布する工程、熱処理して被加工材と塗布したフォトレジストとの密着性を向上させるプリベーク工程、所定のマスクを介して紫外線を露光する露光工程、レジストの露光部分と非露光部分との現像液への溶解性差を利用して一方を選択的に除去する現像工程を最低限要し、必要に応じて更に熱処理してレジストを硬化させるポストベーク工程を行うこともあり、これらの工程を経た後にようやくエッチング処理を施すものであるということから明らかなように、極めて工程数が多く、しかもその何れの工程も比較的高度な操作と熟練性を必要とするものである。

例えば、洗浄工程では加工しようとするレジストパターンの最小寸法に対して１０分の１の大きさの微細な異物の存在がパターン欠陥の原因となるため、極めて厳密な洗浄が必要であり、洗浄後の全ての一連工程において異物の混入、付着等に細心の注意と管理体制が必要である。塗布工程ではフォトレジストを均一な厚みで塗布しなければならず、そのような精密な塗布が可能な塗布装置が必要であり且つ塗布条件を厳密に管理しなくてはならない。露光工程では、マスクを介して高精度な露光を行うためには平行光を発する光源をもつ露光光学系が必要となり、この種の光学特性を有する装置、特に３０センチ角程度以上の有効露光面積を有するものは極めて精密かつ高価な装置となる。さらに高精度な露光光学系としてはレンズやミラーを用いる投影型露光光学系が現在用いられているが、これらのものでは有効露光面積は最大１５センチ角程度が限度であり、しかも上記平行光型のものよりさらに精密かつ高価な装置となる。現像工程ではパターンの現像具合いに変動がないように、現像液の被加工材への接触具合、温度分布等を充分制御できる装置が必要であり且つ充分な管理を要する。

またフォトリソグラフィ法はパターンサイズの比較的大きいシャドウマスク等の金属エッチングの分野で数十μmから数百μmのパターン加工が可能である上、パターンサイズの小さいＬＳＩ等の分野では１μm以下の微細なパターン加工が可能であるが、前述のように非常に特殊で高価な装置を必要とし、特に大型の基板等に対する工程は装置上の制約が極めて大きく且つ装置自体が尚更高価なものになってしまう。

以上のように、フォトリソグラフィ法では極めて高精度、微細なレジストパターン形成が可能であるが、装置上の制約が大きく、設備が高価となり、また工程が多く複雑で且つ長いといった種々の問題がある。

一方、レジストパターン形成を比較的大きな処理能力で且つ比較的安価な装置にて行う手段として印刷法が知られている。例えば、プリント基板等の製造分野ではスクリーン印刷法が用いられ、このような印刷法はエッチング用レジストパターンの形成の他、ソルダーレジストパターン形成等に適用されている。

しかしながら、これら印刷法では微細なパターン形成は極めて困難であり、例えば上記スクリーン印刷法では１００μm以下の線幅のパターンを印刷形成することはできないし、他の印刷法でも同程度である。従って、印刷法では前記フォトリソグラフィ法に比しても装置や工程が簡便となるが、得られるレジストパターンの精度上の問題が大きく、また特に微細なパターン形成ができないという欠点がある。

【課題を解決するための手段】

本発明者等は上記従来技術の問題点を解決するために研究を進めた結果、微細なパターン形成が可能であり設備も簡易なものを使用でき、比較的簡便な工程にて高精度なパターニングができるという成形方法（フォトポリマ法）が、従来のフォトリソグラフィ法や印刷法に代わるレジストパ

ターン形成手段として活用可能であることを見出し、その知見に基づき更に研究を重ねた。

上記フォトポリマ法は、紫外線や電子線硬化性樹脂等の電離放射線硬化性樹脂を成形型とベース材料との間に流し込んで、電離放射線を照射することにより上記樹脂を硬化させて表面に成形型による所望のレリーフ形状を付した成形品を得る成形方法であり、一般にレリーフ形状の複製を行う手法として利用されており、レリーフ形状は1μm以下の大きさのパターンでも忠実に複製することが可能である。そのため最近ではホログラムシートの複製や光メモリーシート、プリズムレンズシート等のレンズシートの製造に適用した技術も提案されている。

しかしながら、この手法はあくまでレリーフ形状の複製を目的としたものであるため、この方法をそのままレジストパターン形成に用いることは当然のことながら不可能であり、それらの点などについても種々検討を重ね、本発明を完成する至った。

即ち本発明は、

(1) 所望のレジストパターンに相応するパターン形状の凹部を設けたマスター版とレジストパターンを形成すべき基板とを、両者間にレジスト用硬化性樹脂を介在させた状態で対峙させ、マスター版と基板をその両側から加圧して硬化性樹脂を挟持し、次いで、熱又は電離放射線を照射して硬化性樹脂を硬化させた後、マスター版を剥離して基板上に硬化樹脂からなる凹凸レリーフ層を形成し、しかる後、全面を均一にエッチングしてはレリーフ層凹部の硬化樹脂を完全に除去すると共にレリーフ層凸部の残存した硬化樹脂からなるレジスト層を形成することを特徴とするレジストパターンの形成方法。

(2) 凸部の層厚Aと凹部の層厚Bの比（A／B）が1.2／1以上となる凹凸レリーフ層を基板上に形成する請求項1記載のレジストパターンの形成方法。

(3) 請求項1記載のレジストパターンの形成方法において、硬化性樹脂に代えて重合性モノマー又は該モノマーと硬化性樹脂との混合物を用いたことを特徴とするレジストパターンの形成方法。

を要旨とするものである。

（実施例）

以下、本発明の実施例を図面に基づき説明する。

第1図は本発明方法の一実施例を示す各工程の断面説明図であり、第2図は本発明方法の他の実施例を示す各工程の断面説明図である。図中1はマスター版、2はマスター版1に設けられたレジストパターンに相応したパターン形状からなる凹部、3はレジストパターンを形成すべき基板、4はレジスト用硬化性樹脂である。本発明では4の硬化性樹脂に代えて、重合性モノマー又は重合性モノマーと硬化性樹脂との混合物を使用しても同様のレジストパターンの形成が行える。

上記マスター版1は、ガラス板や、アクリル、PET、ポリカーボネート、ポリエーテル等のプラスチック板又はフィルム、あるいはステンレス、アルミニウム等の金属板を基材とし、これに直接所望のパターンを機械加工或いはエッチング法で掘り込んで凹部2を形成するか、あるいは前記フォトポリマ法にて凹部2を形成して作成されるものである。基材としてはガラスのような剛直なものよりプラスチック、金属板のようなフレキシブルな素材のほうが、後述のマスター版の剥離工程が容易となる。ガラスを用いても材料の組み合わせにより容易な剥離は可能である。またマスター版1の剥離作業が容易となるように離型剤を凹部2側の面に塗布したり或いは樹脂基材に直接含浸させることができる。離型剤としてはシリコンオイル、ステアリン酸等の高級脂肪酸及びその金属塩等を使用することができ、具体的にはガファックRE410、ガファックRL210、ガファックRD510（以上、東邦化学製）プライサーフ217E、プライサーフA-208S（以上、第一工業製薬製）、レステン（味の素製）等が挙げられる。

基板3は、その材質等については特に限定されない。図示の基板3はいずれも該エッチング層13

を設けた形状のものである。

マスター版1と基板3との間に介在させるレジスト用硬化性樹脂4としては、電子線又は紫外線硬化性樹脂等の電離放射線硬化性樹脂や熱硬化性樹脂等が挙げられる。電離放射線硬化性樹脂は一般にはアクリル型の二重結合が紫外線、電子線のエネルギーにて重合反応して硬化するものであり、具体的には電子線硬化タイプのものとしてゴーセラックUV7000B、ゴーセラックUV4200T（以上、日本合成性）、ダイヤビームUK6034、ダイヤビームUK6039（以上、三菱レーヨン製）等が使用できる。また紫外線硬化を行う場合はこれに光反応開始剤を少量添加しておくことが必要であり、具体的な紫外線硬化タイプのものとしてはダロキュア1173、ダロキュア1116、ダロキュア953（以上、メルク製）、イルガキュア184、イルガキュア500、イルガキュア651（以上、チバガギー製）等が使用できる。

また硬化性樹脂4には必要に応じて粘度調整を行うため反応性希釈剤としてのモノマーを適量添加してもよい。そのモノマーの具体例としてはアロニックスM150、アロニックスM5700（以上、東亜合成製）、カヤラッドHX620、カヤラッドTMPTEA、カヤラッドTC110S（以上、日本化薬製）等が挙げられるが、これらは上記硬化性樹脂と相溶性があることが必要であり適宜選択して使用する。更に硬化性樹脂4には微量の界面活性剤、離型剤等を添加することができる。界面活性剤を添加することにより樹脂組成物の流動性をさらに高めることができ、また低発泡性、抑泡性、高い濡れ性を与え、取り扱い作業性を向上させると同時に後述の凹凸レリーフ層の凹部の肉厚みを極力薄くすることができる。界面活性剤の具体例としてはフローラードFC430、フローラードFC431（以上、スリーエム製）、モダフロー（モンサント製）等が挙げられる。離型剤としては前記のものを同様に使用することができ、この離型剤を添加することによりマスター版からの硬化樹脂層の剥離を容易にすることができると共に剥離時の残留ストレスを少なくすることもできる。

先ず、本発明方法はマスター版1と基板3との間にレジスト用硬化性樹脂4を介在させた後、硬化性樹脂4がサンドイッチされた状態でマスター版と基板の間に薄く均一な厚みで広がるように適宜な加圧手段にてマスター版1と基板3の両側から加圧を行う。

硬化性樹脂4の介在は例えばマスター版1へ滴下にて行うことができ、上記の加圧手段としては第1図(b)に図示の如きロール加圧法の他、第2図(b)に示すように加圧板による加圧法等を採用することができる。加圧手段は上下より加圧板10にて挟持してプレスする方法が最もシンプルであるが、一定に離間した二本の加圧ロール11で挟み圧力をかけながらロールを回転させるロール加圧法が均一な圧力がかけられる点で好ましい。硬化性樹脂4は通常マスター版1の中央部へ滴下する（第2図(a)参照）が、加圧手段としてロール加圧法　適用する場合にマスター版1の一端部付近側に滴下する（第1図(a)参照）ことが樹脂4を均一に拡げるうえで好ましい。本発明方法では上述の硬化性樹脂4をサンドイッチする操作において樹脂組成物中に気泡が混入することのないように操作することが重要である。この対策としては、例えばマスター版1を水平に設置し、この上へ樹脂4を滴下した後、基板3を水平よりやや傾斜させてマスター版1上のに保持し、しかる後、基板3を徐々に下降させ、基板の一端辺がマスター版1にほぼ接するようになった時点で対向する他の端辺を更に下降させてマスター版1に対して平行状態に維持する。このとき樹脂4は基板3に接しながらマスター版1の凹部面をサンドイッチされた状態で広がり始める。この後、マスター版1と基板3の両側よりプレスし、樹脂4をさらに拡げて厚みを均一にすればよい。本発明ではマスター版及び基板の面に対して均一な圧力をかけるため、必要に応じてマスター版1と基板3の両側から空気圧をかける方法やマスター版と基板の間のサンドイッチ状態となっている内側を減圧状態にして大気圧

を利用して均一加圧する方法を適用してもよく、またこれらの方法を併用してもよい。

次いで、熱又は電離放射線5を照射してマスター版1と基板3に加圧状態で挟持されている硬化性樹脂4を硬化させる。

この照射は熱又は電離放射線が伝達、透過可能なマスター版及び／又は基板側から行う。電離放射線としては紫外線、電子線等が使用でき、簡便に利用できる点では紫外線が好ましい。紫外線源としては超高圧水銀灯、高圧水銀灯、メタルハライドランプ等が利用できる。例えば高圧水銀灯では365nmの波長で1J／cm²程度のエネルギーにて充分な硬化が行える。また硬化性樹脂4の硬化のための照射は、前記の加圧を行いながら同時に行うほうが硬化樹脂層の厚みを制御するうえで好ましく、例えば、ロールプレスを行う場合はロールを通過して出た直後に、速やかに紫外線照射して硬化を行うよう構成するのが良い。尚、紫外線の照射の際には光源より熱も放射される場合もあるため、この熱による加熱にてマスター版1及び基板3が熱膨張してパターンの寸法精度が低下するのを防止する為、必要に応じてコールドミラー等を使用して熱線対策を施す必要がある。

次に、硬化性樹脂4を硬化させた後、マスター版1を基板3側から剥離する。

この剥離はマスター版1と基板3のいずれか一方又は両方がフレキシブルな材質であれば極めて容易に行えるが、両方がガラスのような剛直な材質である場合はマスター版1と硬化樹脂層の界面を予め離型処理しておかないと容易に行うことができない。離型処理は前記のシリコンオイル等の離型剤をマスター版1の凹部2側面に塗布するか、或いは硬化性樹脂4に添加する方法により行われる。また剛直な材料どうしの剥離の際は、第2図(a)に示すようにマスター版1と基板3の各々の裏面を吸着盤12等の治具に固定し、この治具を引っ張るようにしてマスター版1又は基板3の一端より徐々に引き剥がすようにするとよい。この際の場合、一端が僅かに剥離し始めた時、その剥離した隙間に高圧空気を吹き込ませればよりスムーズな剥離が可能となる。

上記の剥離により、硬化した樹脂層がマスター版1側から剥離されて基板3側に接着し、その結果、基板3上にマスター版1にて成形された硬化樹脂からなる凹凸レリーフ層6が形成される（第1図(d)、第2図(d)参照）。このレリーフ層6における凹凸の段差はマスター版1の凹凸段差がほぼ忠実に再現されたものであるため、レリーフ層の凹凸段差の制御はマスター版1の凹凸、即ち凹部2の調整のみにて行うことができる。またレリーフ層6の厚み、特に凹部8部分の膜厚は、硬化性樹脂4の粘度、濡れ性、加下量及びマスター版と基板との加圧条件により適宜調整することができる。

本発明方法は最後に、凹凸レリーフ層6が形成された基板3に対して、レリーフ層の凹部8と凸部9の全面に渡って均一になるようなエッチングを行う。このエッチングにより第1図(d)及び第2図(d)に示すようにレリーフ層凹部8のみの硬化樹脂を完全除去され、レリーフ層凸部9の硬化樹脂は凹部8と同量除去されるがその一部が残存し、この残存した硬化樹脂部分から構成されるレジスト層7が基板3上に形成される。

上記エッチングは硬化性樹脂4の組成によって薬品類あるいは溶剤を用いて行うエッチング法も適用可能であるが、通常の硬化性樹脂では薬品あるいは溶剤にて溶解されるに先立って硬化樹脂層の膨潤が起きる場合が多いため、厚が厚い箇所も薄い箇所も同様に膨潤してしまい、レリーフ層のパターン形状に変形が生じるので、本発明で要求される選択的に層の薄いレリーフ層凹部のみを完全に溶解除去することが困難であるという不具合がある。

そのため、本発明者等の検討結果により上記エッチングとしてはドライエッチング法が最も好ましいことが確認されている。このドライエッチング法は被エッチング材となる有機物表面が活性ガス（例えば酸素プラズマ）と反応して気化するので被エッチング材の表面側から順次エッチングがなされる。本発明では、この　性を利用すること

によりレリーフ層6の硬化樹脂層の表層より膜厚方向に徐々にエッチングを進めることが可能となり、しかもそのエッチング速度はレリーフ層の凹部及び凸部にかかわらず一様であるので、結果的に、膜厚の薄いレリーフ層凹部8の硬化樹脂のみを始めに完全且つ確実に除去することができ、膜厚の大きいレリーフ層凸部9の硬化樹脂を一部残すことが可能となるわけである。ドライエッチング法としてはプラズマエッチング法、オゾン酸化によるエッチング法が挙げられる。

本発明方法において上記レリーフ層6のエッチングにより良好なレジスト層7を形成し得るためには、レリーフ層の凸部9の膜厚Aと凹部8の膜厚Bの比（A／B）が1.2／1以上となる凹凸レリーフ層5を形成せしめることが重要である。この膜厚の比率が上記数値範囲により小さい場合は、凹部8のみの硬化樹脂を完全除去し、凸部9の硬化樹脂を一部残存させるようなエッチング処理を行い難く、また実用によるエッチング法では特に凹部8と凸部9との溶解性差が小さいと凹部8、9における硬化樹脂が一緒に溶解除去されてしまう欠点がある。尚、ドライエッチング法の適用する場合、レリーフ層の凹凸差はエッチング処理面積が小さければサブミクロンの差でもよく、例えば処理面積が1cm×1cmのエッチング加工では0.2μm差でもレジスト形成が可能であるが、処理面積が大きくなる場合には凹凸差も大きめに設定する必要がある。

以上の如き本発明方法によるレジストパターンを形成した後の基板3は、その後、通常のエッチング処理を施し、最後にレジスト層7を除去すれば、基板3に対する所望のパターン加工が完了する。

本発明のレジストパターンの形成方法は、半導体製造のための微細なレジストパターン形成を始めとして、微細パターン形成が要求される種々の製品製造のパターン形成方法として適用することができる。

次に、具体的実施例を挙げて本発明を更に詳細に説明する。

実施例1

第1図に図示の如き実施例に沿ってレジストパターンの形成を行う。

まず、縦横15cmで厚み0.3mmのポリカーボネート基材上に紫外線硬化性樹脂を用いたフォトポリマ法にて深さ2μmのレリーフパターン凹部を形成したものをマスター版1として使用し、このマスター版の左端（ロール4側）に紫外線硬化性樹脂組成物4をフローコート法より滴下した（同図(a)）。この樹脂組成物はオリゴマーとしてIPDIベースのウレタン系アクリレート樹脂（日本合成製：ゴーセラックUV7000B）を30重量%、モノマーとしてカヤラッドHX220（日本化薬製）を70重量%の割合で混合し、さらに光反応開始剤としてイルガキュア184（チガガイギー製）を2重量%添加し、粘度180cpsに調整された樹脂組成物である。

基板3として、ガラス基板上に酸化インジウム（ITO）を10Ω／□に成膜した厚さ1mmのものを使用し、この基板3を上方よりマスター版1に向けて接近し、加圧ロール11を速度50cm／分で図中右方向に転動して加圧した（同図(b)）。このとき図中Pで示す部分でマスター版1と基板3の間に存在する気泡が追い出される。またロール加圧を行った直後に紫外線光源を用いて160W／cmで紫外線を照射し、紫外線硬化性樹脂4を硬化させた（同図(c)）。

次に、マスター版1を離圧剥離して基板3上に凹凸レリーフ層6を形成せしめた（同図(d)）。このレリーフ層は凹凸段差が2μm、凹部の厚みが1μm、凸部の厚みが3μmであった。

最後に、レリーフ層を酸素プラズマにてドライエッチングして凹部の硬化樹脂を完全除去し、レリーフ層凸部9のパターンと同一のパターン形状のレジスト層7を形成し得た。凸部9の硬化樹脂も凹部8と同様にエッチングされ、結局厚みが2μmに減じた。

レジストパターンが形成された基板3を塩化鉄系エッチング液にてエッチングし、レジスト層を除去することにより、レジスト層7と同様のパタ

ーンからなるＩＴＯ層を得ることができた。

実施例２

第２図に図示の如き態様の実施例に沿ってレジストパターンの形成を行う。

まず、縦横３０cmの厚み３mmのガラス基板上にフォトリソグラフィ法にて表面を深さ３μmの所定のパターン凹部をエッチングし、しかる後、表面に離型剤としてシリコンオイル（東邦化学製：ガファックＲＥ６１０）を塗布し、マスター版１を作成しこのマスター版１の中央部に実施例１と同じ紫外線硬化性樹脂組成物４を滴下した（同図(ロ)）。

次いで、実施例１と同じＩＴＯ層を有するガラス基板３を若干斜めに傾斜し、マスター版に徐々に押し付けた（同図(ハ)）。このとき図中Ｐで示す部分でマスター版１と基板３の間にある気泡が追い出される。

次に、加圧板10、10にてマスター版３と基板１とを上下よりプレスした。下側の加圧板10のマスター版１と接する部位を透明なガラス製で構成し

てプレスと同時に下側の加圧板10から、１６０Ｗ／cmで紫外線を３０秒間照射して樹脂組成物４を硬化させた（同図(ニ)）。

硬化後、解圧してから吸盤12にてマスター版３と基板１の裏面を吸着しながら両者を剥離し、基板３上に凹凸レリーフ層６を形成せしめた（同図(ホ)）。このレリーフ層は凹凸段差が３μm、凹部８の厚みが１μm、凸部９の厚みが４μmであった。

最後に、レリーフ層を酸素プラズマにてドライエッチングして凹部８の硬化樹脂を完全除去し、レリーフ層凸部パターンからなるレジスト層７を成形し得た（同図(ヘ)）。凸部９の硬化樹脂も凹部と同様にエッチングされ、結局層厚が３μmに減じた。

実施例３

第２図に示す態様例に沿ってレジストパターンの形成を行った。

まず、実施例２と同様のマスター版３の中央部にオリゴエステルアクリレート系紫外線硬化性樹

脂組成物４を滴下した。この樹脂組成物４はカヤラッドＴＭＰＴＡ（日本化薬製）９８重量％に光重合開始剤としてイルガキュア１８４（チバガイギー製）を２重量％添加したものである。

次いで、実施例１と同じＩＴＯ層13を有する基板３を若干斜めに傾斜し、マスター版に徐々に押しつけた。次に、実施例２と同様の加圧手段にてマスター版と基板を加圧するとともに、下側の加圧板より実施例２と同様に１６０Ｗ／cmで紫外線を３０秒間照射し、紫外線硬化樹脂４を硬化させた。

次に、実施例２と同様に吸盤を利用してマスター版３と基板１を剥離して、基板３上に凹凸レリーフ層６を形成せしめた。このレリーフ層は凹凸段差が３μm、凹部の厚みが１μm、凸部の厚みはが４μmであった。

最後に、レリーフ層を有する基板を２％苛性ソーダ水溶液にてエッチングしてレリーフ層凹部の硬化樹脂を除去し、レジスト層を得た。このとき凸部の硬化樹脂もエッチングされて膜厚が３μmに減少した。

（発明の効果）

以上説明したように本発明方法によれば、従来のフォトリソグラフィ法に匹敵する微細かつ高精度なレジストパターン形成が可能であり、またパターン形成に当たってフォトリソグラフィ法で使用するような高価、複雑な装置を用いる必要がなく、しかも煩雑な管理をせずに比較的単純で数少ない短い工程にて成し得ることができ、従って、レジストパターンの形成を従来方法に比して簡便に且つ高精度で効率良く行うことができる。また基板に形成する凹凸レリーフ層の凹部と凸部の層厚を前記の如く特定比率に設定すれば、より一層確実、鮮明で且つ再現性良好なレジストパターンの形成が可能となる。

4.図面の簡単な説明

第１図は本発明方法の一実施例を示す各工程の断面説明図、第２図は本発明方法の他の態様例を示す各工程の断面説明図である。

１…マスター版　　２…凹部　　３…基板

4…レジスト用硬化性樹脂
5…熱又は電離放射線
6…凹凸レリーフ層　　7…レジスト層
8…レリーフ層凹部　　9…レリーフ層凸部

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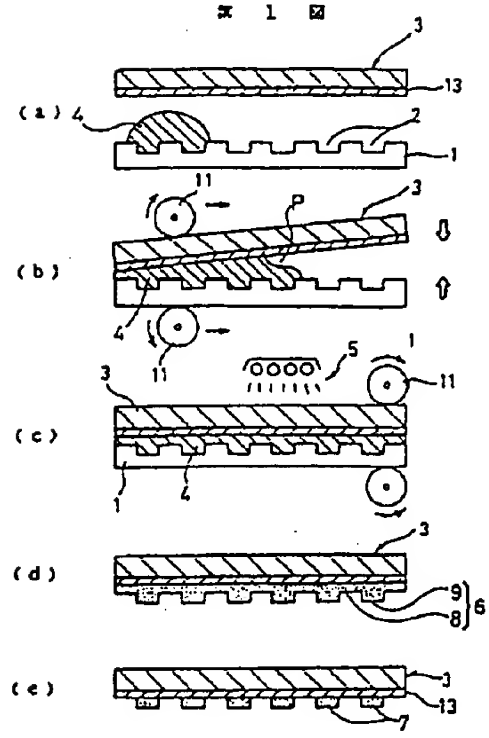
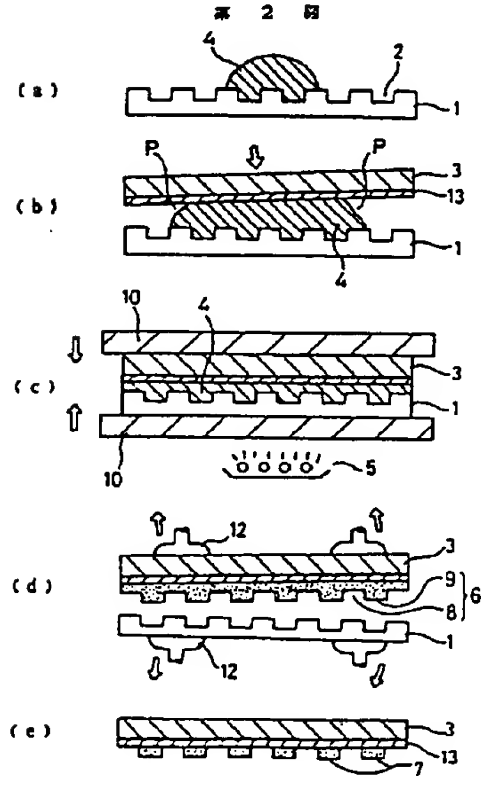
第　1　図



第　2　図



← 全面エッチング